भारतीय मानक

Indian Standard

IS 14603 : 2023

आलू ग्रेडर — परीक्षण संहिता

(पहला पुनरीक्षण)

Potato Grader — Test Code

(First Revision)

ICS 65.060

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भारतीय मानक ब्यूरो
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Agriculture and Food Processing Equipment Sectional Committee, FAD 20

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Agriculture and Food Processing Equipment Sectional Committee had been approved by the Food and Agriculture Division Council.

Potato is an important food and vegetable crop, which is grown in India. One of the post-harvest operations for which potato growers and cold storage owners are presently facing hardships is the separation of potatoes into different size-grades. This is known as ‘grading’. Grading helps the farmers in getting higher profit for their produce when sold in the market. Different types of potato graders have been developed and are being manufactured in the country. Therefore, a need was felt to formulate this standard in order to have a uniform test procedure to evaluate the performance of potato graders.

This standard was originally published in 1998. In this revision, the damage index parameter has been incorporated as additional performance assessment requirement. Further, the provision for accelerated bruising assessment has been incorporated. Also, the standard has been brought out in the latest style and format of the Indian Standards.

The composition of the committee responsible for the formulation of this standard is listed in Annex J.

In reporting the result of a test or analysis made in accordance with this standard, is to be rounded off, it shall be done in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’.

Indian Standard

POTATO GRADER — TEST CODE

(First Revision)

1 SCOPE

This standard prescribes the method for testing of hand and power operated potato graders.

2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

2.1 Potato Index (*I*) — It is defined as below:

$$I = \frac{L^2}{WT}$$

where

L = greatest length, mm;
W = greatest width, mm; and
T = greatest thickness, mm.

The dimensions L, W and T are respective averages from corresponding measurements of at least 50 tubers.

Depending upon the values of I the tuber shape can be defined as follows:

Round	From 100 up to and including 160
Oval	Above 160 up to and including 240
Long	Above 240 up to and including 340
Very long	Above 340

2.2 Square Measure — Pass at least 50 potatoes through a set of 7 square mesh sieves. The mesh width ranges from 25 mm to 55 mm in 5 mm steps. The square measure is indicated by stating the minimum size sieve through which none of the sample will pass and the maximum size through which whole of the sample will pass. It is expressed as mm/mm; for example, 35 mm/50 mm.

2.3 Bulk Density — Mass per unit volume of potato tubers expressed in kg/m^3.

2.4 Size Range — It is calculated on the basis of tuber width by the following expression:

$$Size\ range = W \pm \mathrm{SD}$$

where

W = mean tuber width; and
SD = standard deviation.

2.5 Grading Efficiency — The percentage of number of potato tubers conforming to a desired grade separated by a grader to the total number of tubers fed into the machine in a given lot. It can also be specified on the basis of the mass of desired grade tuber separated to the total mass of tubers in a given lot. It can be obtained by subtracting the grading error (*see* 2.8) from 100 when expressed in percentage.

2.6 Skinning Damage — The percent damage caused to the potato tubers by the action of a grader on the basis of the percent skin of the potato tubers removed.

2.7 Cutting Damage — The percent damage caused to the tubers due to the cut injuries resulting from the action of the grader.

2.8 Bruising Damage — The percent damage caused to the potato tubers as a result of the bruising sustained to the tubers due to the operation of the grader. Bruising, essentially, implies the damage or rupture of the tissues of potato tubers without breaking of the skin. A bruised tuber develops a dark spot at the place of bruising after a few days.

3 SELECTION AND PREPARATION OF GRADER FOR TEST

3.1 Selection

For the commercial test, the grader shall be selected at random from the production line as directed by the Test Station. The Grader shall be complete with all accessories and in a condition generally offered for sale. The grader shall be new and shall not be given any special treatment or preparation for the test. The manufacturer can submit his machine for confidential testing, if so desired. The nature of test required by the manufacturer shall be stated.

3.1.1 The manufacturer shall give a specifications sheet for the grader comprising all items listed in the specimen format given in Annex A and any further data required to carry out the tests.

3.2 Preparation of Grader for Test

3.2.1 *Running-in*

The grader shall be run-in before the test, under the supervision of the manufacturer. It shall be checked for its completeness. Particular attention shall be paid to the power transmission system and other moving parts, bearings, functioning of the grading, units/members, tightness of various fasteners namely, nuts, bolts, keys etc. The test report shall mention the place and duration of the running in.

3.2.2 *Preliminary Adjustments*

Necessary adjustments may be made by the manufacturer during the running-in period. Once the grader is prepared for the test, the adjustments shall not be changed during the test. In case, it becomes necessary to change the settings, alterations made shall be reported.

4 INSTRUMENTATION

4.1 The accuracy of measuring instruments shall have maximum allowable errors as follows:

a) Rotational speed, rev/min ± 0.5 percent;
b) Time, s ± 0.2;
c) Length, m or mm ± 0.5 percent;
d) Force, N ± 1.0 percent;
e) Mass, kg ± 0.5 percent;
f) Atmospheric pressure, kPa ± 0.2; and
g) Atmospheric temperature, ºC ± 0.5.

5 CHECKING OF SPECIFICATIONS

The specifications supplied by the manufacturer shall be checked and reported in the format given in Annex A.

6 CHECKING OF MATERIAL

The material of construction of various components of the grader shall be reported in the format given in Annex B.

7 VISUAL OBSERVATION AND ADJUSTMENTS

7.1 The grader shall be examined visually and following observations shall be reported:

a) Adequacy of marking of feed trough and outlets;
b) Adequacy of marking of direction of rotation of main drive shaft;
c) Adequacy of protection of bearings against the ingress of dust;
d) Adequacy of safety arrangement, especially at moving points and at feed trough;
e) Provision for lubrication of moving parts:
f) Provision for belt tightening;
g) Provision for transportation;
h) Provision for changing of components requiring replacement;
j) Provision for replacement and cleaning of grading spools/sieve/conveyor;
k) Provision for anti-corrosive coatings;
m) Welding of seams;
n) Tightness of bolts, nuts and other fasteners; and
p) Other observations.

7.2 The grader shall be examined for following provisions for adjustments:

a) Feed rate;
b) Speed;
c) Pitch of sizing rollers/sieves;
d) Grade sizes; and
e) Slope of collecting platform/grading outlets.

8 TESTS AT NO LOAD

8.1 Installation for Testing

The grader shall be installed on a level, preferably, hard surface and set the slope of the sizing bed or conveyor(s) in accordance with the manufacturer's recommendations. As far as possible, the test shall be conducted under still-air condition. The grader shall be attached with a suitable prime over, preferably an electric motor fitted with energy meter or transmission dynamometer for measuring the power input. The power delivered to the grader should be supplied in either of the following ways:

a) Direct coupling of the prime mover with the main driving shaft; or
b) Connecting the prime mover with the help of flat or V-belt and pulleys with main driving shaft of the grader.

In case of (a) the power delivered to the grader will be the power output of the prime mover; whereas in case of (b) the allowances for flat belt and V-belt drive losses may be taken as 6 percent and 3 percent respectively.

8.2 Energy Consumption

8.2.1 The energy meter shall be set by running the grader for 10 minutes and the initial readings of the energy meter shall be recorded. The energy consumption shall be measured at no load for one hour.

8.3 The data shall be recorded as well as visual observations during and after the test in the format given in Annex C.

9 TESTS AT LOAD

9.1 Short-Run Test

9.1.1 The grader shall be installed as specified in **8.1** if no-load test was conducted at different place.

9.1.2 *Operation and Collection of Data*

Sufficient quantity of potatoes of each variety shall be taken for conducting the short duration test. The grader shall be operated at the specified speed of the grading unit for one hour at the maximum input capacity. During the one hour run period the following samples and data shall be collected :

a) Three sets of samples shall be taken at an interval of about 20 minutes including the time for sample collection from the different outlets of the grader;
b) The speed of the different shafts by revolution counter or a hand tachometer shall be recorded; and
c) In case of electric prime-mover, the readings of energy meter or dynamometer shall be taken at an interval of one hour.

At the end of one hour operation, the grader shall be run idle for some time, so that the material earlier fed into the grader comes out. The graded material collected from different outlets shall be weighed. If an engine has been used as prime-mover, the fuel consumption during the operation period shall be recorded.

9.1.3 The test given in **9.1.2** shall be repeated for minimum three times at different feed rates covering the rated input capacity and approximately 50 percent of the maximum input capacity at specified speed; speed 15 percent higher than specified speed, and speed 15 percent lower than the specified speed.

9.1.4 The data shall be recorded as well as visual observations in the data sheet as given in Annex D.

9.1.5 *Analysis of the Sample*

The samples obtained at different outlets of the grader for different feed rates shall be analyzed for the following:

a) For cut tubers, by number and by mass, for each outlet;
b) Skinned tubers, by number and by mass, for each outlet;
c) Bruised tubers, by number and by mass for each outlet; and
d) Damage Index.

The average for three sets obtained at different feed rates shall be reported.

9.1.5.1 The data shall be recorded in data sheet as given in Annex E.

9.1.6 *Calculation*

9.1.6.1 *Grading error*

It shall be calculated on the basis of the tuber numbers or tuber mass. The following formulae shall be used for the calculations: On the basis of tuber mass:

a) Percent grading error for Grade 1:

$$E_1 = \frac{(M - M_1) \times 100}{M}$$

b) Percent grading error for Grade 2:

$$E_2 = \frac{(M - M_1) - M_2 \times 100}{(M - M_1)}$$

c) Percent grading error for Grade 3:

$$E_3 = \frac{(M - M_1 - M_2) - M_3 \times 100}{(M - M_1 - M_2)}$$

Hence overall grading error for the Grader:

$$E = \frac{E_1 + E_2 + E_3}{3}$$

where

M = Total mass of tubers, kg;
M_1 = Mass of tubers for Grade 1, kg;
M_2 = Mass of tubers for Grade 2, kg; and
M_3 = Mass of tubers for Grade 3, kg.

Similarly, overall grading error for the grader shall be calculated on the basis of numbers of tubers collected in each grade.

9.1.6.2 *Skinning damage*

It shall be calculated as follows:

$$D_s = \frac{M_s \times 100}{M}$$

or

$$D_s = \frac{N_s \times 100}{N}$$

where

D_s = skin damage, percent;

M_s = mass of potatoes with damaged skin, kg;

M = total mass of tubers in a sample, kg;

N_s = number of tubers with damaged skin; and

N = total number of tubers, in a sample.

9.1.6.3 *Cutting damage*

It shall be calculated as follows:

$$D_c = \frac{M_c \times 100}{M}$$

or

$$D_c = \frac{N_c \times 100}{N}$$

where

D_c = cutting damage, percent;

M_c = mass of cut tubers in a sample, kg;

M = total mass of tubers in a sample, kg;

N_c = number of cut tubers in a sample; and

N = total number of tubers in a sample.

9.1.6.4 *Bruising assessment*

As bruise one potato will normally take 3 days or 4 days to develop, the bruising process can be accelerated by storing a sample in warm humid conditions overnight. A hotbox is ideal for this. The hot box needs to be able to maintain 34 ºC to 36 ºC and 95 percent to 98 percent RH.

Once the sample has been stored in hot-box overnight, the assessment can be completed. Careful peeling shall be done around the tuber to look for black/grey discolouration of the flesh below the skin. The findings shall be categorized as Nil, Slight or Severe. The slight bruises being removed by 2 peels and severe bruises not being removed by 2 peels. It is suggested to assess samples in batches of 25 tubers, which makes it easy to calculate percent bruising in each category.

a) Size of Hotbox — Hotbox shall be of three sizes as illustrated in the table below depending on the testing material.

b) Material — Hotbox shall be made of strong, insulated UPVC casing with sealed door and wipe-clean surfaces.

c) Bruising categorization

Sample of 25 numbers of potato tubers shall be taken and bruising assessment shall be carried out as follows:

Bruising type	Number of tubers
1) Nil bruising	----------------------------
2) Slight	----------------------------
3) Severe	----------------------------

The percentage of slight and severe bruising shall be calculated.

Hotbox Size	*Tuber capacity (number)*	*Trays*	*Dimensions (width × depth × height) (cm)*	*Weight (kg)*
Hotbox 125	125	5	89w x 70d x 72h	45
Hotbox 250	250	10	89w x 70d x 120h	76
Hotbox 750	750	30	153w x 70d x 176h	160

d) Bruising damage percentage: It shall be calculated as follows:

$$D_b = \frac{M_b \times 100}{M}$$

or

$$D_b = \frac{N_b \times 100}{N}$$

where

D_b = bruising damage, percent;
M_b = mass of bruised tubers in a sample, kg;
M = total mass of tubers in a sample, kg;
N_b = number of bruised tubers in a sample; and
N = total number of tubers in a sample.

9.1.6.5 *Damage index*

Depending on how much damage is being encountered, the sampling should be repeated at various times throughout the day, especially if the variety has been changed or the machinery setting have been re-adjusted.

A sample size shall be of 15 kg to 20 kg of tubers. All traces of soil should be carefully washed from the sample. It is suggested to use copious amounts of water and a sponge (mechanical washers tend to cause some damage which may interfere with assessment). Tubers should then be inspected and divided into categories – Undamaged, Scuffed, Slight, and Severe.

“Scuffed” — broken skin only, with no flesh damage.

“Slight” — flesh damage removable by 2 strokes of a peeler.

“Severe” — damage not removed by 2 strokes of a peeler.

Then their percentages based on weights of their corresponding fractions shall be determined by using following formula:

$$Damage\ Index = (\%\ Scuffed) + (\%\ Slight \times 3) + (\%\ Severe \times 7)$$

Index (d) should be as low as possible and the lower the index the less damage is being caused.

Damage Type	*Weight of Tubers, g*	*% Total Weight*	*Factor*	*Damage Index, d*
Undamaged	a	c = (a/b*100)	0	= c x factor
Scuffed	s_1		1	d_1
Slight	s_2		3	d_2
Severe	s_3		7	d_3
Total	$B = s_1 + s_2 + s_3$			$d = d_1 + d_2 + d_3$

9.1.7 *Determination of Energy Consumption*

9.1.7.1 In case of energy meter fitted with prime mover, the difference between two consecutive readings shall give the energy consumption for 60 minutes. Calculate the energy consumption for 1 hour giving due allowances to the type of drive. The allowances for flat belt and V-belt drive losses shall be taken as 6 percent and 3 percent respectively.

9.1.7.2 In case of dynamometer fitted with prime mover the average reading taken shall give the average torque. The power requirement shall be calculated by the following formula:

$$Power\ (kW) = \frac{Torque\ (N.m) \times Speed (rev/min)}{9\ 549.297}$$

9.1.7.3 The data shall be recorded in data sheet as given in Annex F.

9.1.8 *Determination of Rated Capacity*

The feed rate at which the grading errors are within ± 5 percent shall be selected. Capacity in terms of energy consume shall be calculated by dividing the capacity by power consumed.

9.1.8.1 The data shall be recorded in data sheet as given in Annex F.

9.1.9 *Determination of Output Capacity*

The mass of graded potatoes received at different outlets shall be taken and recorded in the data sheet given in Annex F.

9.2 Long Run Test

The grader shall be operated for at least 10 hours at load which should be covered by continuous run of at least 5 hours. The major break-downs/defects developed and repairs made shall be recorded in data sheet as given in Annex G.

10 SUMMARY

For the guidance of the users, a summary report shall be compiled in data sheet as given in Annex H.

ANNEX A

(*Clauses* 3.1.1 and 5.1)

PERFORMANCE INDICATORS FOR POTATO GRADING MACHINES

A-1 GENERAL

Potato-grading machines designed to work on small-scale farms in the developing world must satisfy both technical and economic requirements, as well as considering social factors for successful technology adoption. Machines must not only be suitable for use in harsh physical conditions, but they must also be profitable to the farmer.

A-2 SPECIFICATIONS SHEET

A-2.1 General

a) Make
b) Model
c) Type
d) Year of manufacture

A-2.2 Power Unit

a) Provisions for installation of power unit
b) Type of prime mover recommended
c) Rotated power, kW
d) Type of drive

A-2.3 Main Drive

a) Type
b) Size of belt or chain, mm
c) Size of pulley or size of sprocket, mm
d) Diameter of main shaft, mm

A-2.4 Feeding System

a) Method of feeding
b) Height of feeding-trough, if any
c) Type of feeding conveyor, if any
d) Width of feed conveyor, if any
e) Conveying distance: Horizontal
Vertical
f) Feed-conveyor drive

A-2.5 Grading System

a) Type
b) Number of spools/sieves/grading conveyors
c) Pitch between spools or size of holes in the grading sieves or grading conveyors
Minimum (mm)__________________
Maximum (mm)__________________
d) Width of spools or grading sieves/conveyors(mm)
e) Drive

A-2.6 Collecting Platform/Delivery Chutes

a) Length and breadth (mm × mm)
b) Slope (deg)
c) Number of dividers provided
d) Number of grading outlets

Performance Indicators for Potato Grading Machines	
Technical Indicators	
Rate of sorting	Capacity of the machine to sort potatoes (tubers/h)
Accuracy of sorting	Capacity to correctly classify potatoes (% correctly sorted tubers)
Damage	Capacity to grade the potatoes without causing undue damage to the tuber (% damaged tubers)
Economic Indicators	
Investment	Amount of initial capital investment (Rs.)
Profitability	Lifetime profitability of the machine (Internal rate of return)
Social Indicators	
Flexibility and usability	Ease of use and flexibility of the machine (Qualitative evaluation)
Transportability	Ease with which it can be transported between farms and regions (Qualitative evaluation)
Safety	Assessment of risk of injury by grader (Qualitative evaluation)

A-2.8 Transport Wheels

a) Number and size of wheels
b) Type of wheel-bearings
c) Type of towing arrangements, if any

A-2.9 Overall Dimensions

a) Length with feed conveyor (mm)
b) Length without feed conveyor (mm)
c) Width (mm)
d) Height with feed conveyor (mm)
e) Height without conveyor (mm)

A-2.10 Number of Man Power Required to Operate the Machine

A-2.11 Tool Weight (kg)

A-2.12 Input Capacity (kg/h)

ANNEX B

(*Clause* 6.1)

CONSTRUCTION OF VARIOUS COMPONENTS OF THE GRADER

B-1 DATE OF TEST

B-2 MATERIAL OF CONSTRUCTION

Sl No.	*Component*	*Material*	*Size*
i)	Frame		
ii)	Feed conveyor(s)		
iii)	Grading conveyors/sieve(s)		
iv)	Shaft		
v)	Pulleys/chains		
vi)	Transport wheels		
vii)	Platform		
viii)	Outlet		
ix)	Transport wheels		
x)	Others		

ANNEX C

(*Clause* 8.3)

DATA SHEET FOR TEST AT NO-LOAD

C-1 ENERGY CONSUMPTION

a) Source of power;
b) Type of drive;
c) Total time of run;
d) Average energy consumption for one hour;
e) Speed of feed conveyor; and
f) Speed of grading conveyor(s)/sieves.

C-2 VISUAL OBSERVATIONS

a) Presence of any marked vibrations during operation;
b) Presence of undue knocking or rattling sound;
c) Frequent slippage of belts;
d) Smooth running of shaft in their respective bearings;
e) Any unusual play or slackness in any components;
f) Any marked rise in temperature of bearings; and
g) Other observations.

ANNEX D

(*Clause* 9.1.4)

DATA SHEET FOR TEST AT LOAD

a) Source of power
b) Power rating
c) Type of drive
d) Variety of potato
e) Potato index
f) Size of different grades of potatoes
g) Speed of feed conveyors
h) Speed of grading conveyors/sieves
j) Slope of collecting platform
k) Test data

Sl No.	*Date*	*Starting Time*	*Stopping Time*	*Duration of Operation*	*Speed (rev/min)*	*Feed Rate (kg/h)*	*Power Required (kW)*	*Number of Samples*	*Weight (kg)*			*Total weight of graded potatoes (kg)*
									Grade I	*Grade II*	*Grade III*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)			(11)

NOTES

1 The data should be taken for the tests conducted at different feed rates.

2 Tests should be conducted at specified speeds and at speeds 15 percent less and 15 percent higher than specified.

ANNEX E

(*Clause* 9.1.5.1)

DATA SHEET FOR ANALYSIS OF SAMPLES

Sl No.	*Feed rate (kg/h)*	*Speed of main shaft (RPM)*	*Mass of samples (kg) from*			*Mass (g)*			
			Grade I	*Grade II*	*Grade II*	*Cut Tubers*	*Bruised Tubers*	*Split Tubers*	*Skinned Tubers*
(1)	(2)	(3)	(4)			(5)			

ANNEX F

(*Clauses* 9.1.7.3, 9.1.8 and 9.1.9)

DATA SHEET FOR GRADING ERRORS, ENERGY REQUIREMENT AND CAPACITY

Sl No.	*Item*	*Tests*					*Grader Speed (RPM)*	*Feed rate (kg/h)*	*Power required (kW)*	*Mass of Tubers collected at different outlets (kg)*
		1	2	3	4	5				
(1)	(2)	(3)					(4)	(5)	(6)	(7)
i)	Skinned tubers, percent									
ii)	Cut tubers, percent									
iii)	Bruised tubers, percent									
iv)	Split tubers, percent									
v)	Skinned tubers, percent									
vi)	Damage Index									
vii)	Rated input capacity (kg/h)									
viii)	Rated input capacity (kg/kWh)									
ix)	Output capacity (kg/h)									

ANNEX G

(*Clause* 9.2)

DATA SHEET FOR LONG RUN TEST

1. Date……………………………………………………………………………………….
2. Variety of potato……………………………………………………………………
3. Output capacity (kg/h) ……………………………………………………………………
4. Total running time (h)…………………………………………………………………….
5. Continuous running time (h)…………………………………………………………..
6. Break downs, if any………………………………………………………………..
7. Major repairs conducted, if any………………………………………………………..
8. Persons needed for operation…………………………………………………………..
    a) Man-hour needed for operation…………………………………………………
    b) Man-hour needed for removing the bags………………………………………….
9. Any other observations…………………………………………………………………..

ANNEX H

(*Clause* 10)

SUMMARY REPORT

1. Name of the manufacturer……………………………………………………………..
2. Model number……………………………………………………………………..
3. Name of testing centre…………………………………………………………………
4. Brief description of the grader…………………………………………………………..
5. Variety of potatoes used in the test………………………………………………………..
6. Potato index……………………………………………………………………………
7. Adjustments
   a) At no load…………………………………………………………………………….
   b) Speed of main conveyor………………………………………………………………
   c) Speed of different grading conveyors/sieves……………………………………………
8. Power requirement, kW……………………………………………………………..
   a) At no load…………………………………………………………………………….
   b) At load using rated input capacity………………………………………………………
9. Percentage of skinned tubers……………………………………………………………..
10. Percentage of cut tubers……………………………………………………………………….
11. Percentage of split tubers…………………………………………………………………..
12. Percentage of bruised tubers………………………………………………………………….
13. Damage Index…………………………………………………………………………….
14. Rated input capacity, kg/h……………………………………………………………………
15. Variation of rated input capacity……………………………………………………………..
    a) At 15 percent more than specified speed……………………………………………..
    b) At 15 percent less than specified speed………………………………………………..
16. Rated input capacity, kg/kWh…………………………………………………………..
17. Output capacity, kg/h…………………………………………………………………..
18. Output capacity, kg/kWh……………………………………………………………………..
19. Grading efficiency, percent……………………………………………………………………
20. Any marked observations affecting performance……………………………………………
21. Any marked breakdowns………………………………………………………………………..
22. Other observations…………………

ANNEX J

(*Foreword*)

COMMITTEE COMPOSITION

Agriculture and Food Processing Equipment Sectional Committee, FAD 20

Organization	*Representative*(*s*)
Indian Council of Agricultural Research, New Delhi	DR SHYAM NARAYAN JHA **(*Chairperson*)**
Agriculture Machinery Manufacturers Association, Pune	DR SURENDRA SINGH SHRI MITUL PANCHAL (*Alternate*)
CCS Haryana Agricultural University, Hisar	DR RAVI GUPTA
Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola	DR SUCHITA V. GUPTA DR BHAGYASHREE N. PATIL (*Alternate*)
Essen Multipack Limited, Rajkot	SHRI SHAILDIP WAGH
ICAR – Central Institute of Agricultural Engineering, Bhopal	DR S. K. GIRI DR RAVINDRA NAIK (*Alternate*)
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ICAR – Central Institute of Women in Agriculture, Bhubaneswar	DR SACHIDANANDA SWAIN ER CHAITRALI S. MHATRE (*Alternate*)
ICAR – Indian Institute of Horticultural Research, Bengaluru	DR A. CAROLINA RATHINA KUMAR DR S. BHUANESWARI (*Alternate*)
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Indian Council of Agricultural Research, New Delhi	DR KANCHAN K. SINGH DR PANNA LAL SINGH (*Alternate*)
National Institute of Food Technology, Entrepreneurship and Management, Thanjavur	DR S. BHUVANA
Indosaw Industrial Products Private Limited, Ambala Cantt.	DR VINOD H. KALBANDE
Mahatma Phule Krishi Vidyapeeth, Rahuri	PROF VIKRAM PARASHARAM KAD
Ministry of Agriculture, Department of Agriculture, New Delhi	SHRI C. R. LOHI SHRI Y. K. RAO (*Alternate*)
National Committee on Precision Applications in Horticulture, New Delhi	SHRI ANAND ZAMBRE
National Institute of Food Technology Entrepreneurship and Management, Sonipat	DR P. K. NEMA
North Eastern Region Farm Machinery Training and Testing Institute, Biswanath Chariali	DR P. P. RAO SHRI S. G. PAWAR (*Alternate*)

Organization	*Representative(s)*
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Osaw Agro Industries Private Limited, Ambala	Shri Jagdish Singh
Punjab Agricultural University, Ludhiana	Dr Sandhya Singh Dr Maninder Kaur (*Alternate* I) Dr Rohit Sharma (*Alternate* II)
Tamil Nadu Agricultural University, Coimbatore	Dr R. Thirupathi Dr P. Rajkumar (*Alternate* I) Dr P. Sudha (*Alternate* II)
In Personal Capacity (*320 1st E cross HRBR layout 3rd block St Thomas Town Post, Bangaluru - 560084*)	Shri Jix Antony
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